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INSTRUCTION MANUAL

FOR

PRECISION AC-DC VOLTMETER

MODEL AC-100A

CALIB.

ELECTRONIC INSTRUMENTATION FOR INDUSTRY

CALIBRATION STANDARDS CORPORATION *a subsidiary of* ROYAL INDUSTRIES, INC.

I/N ELECT. CALIB.
D/3272-5

PRECISION AC-DC VOLTMETER

MODEL AC-100A

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SERIAL # 1303

CALIBRATION STANDARDS CORPORATION
ALHAMBRA, CALIFORNIA

CUmberland 3-8156

CS4-501

Issued

IMPORTANT

FOR OPTIMUM RESULTS READ THIS INSTRUCTION MANUAL CAREFULLY

The instrument covered in this manual is of an advanced design in the field of transistorized precision test equipment.

You will find this instrument has many distinct advantages over the operating characteristics found in equipment costing many times as much.

Since this instrument incorporates advanced engineering techniques and design, it is imperative that you become familiar with the proper operating procedure.

One of the superior features found in this instrument is the elimination of the usual electronic zero controls. The meter need only be zeroed by the mechanical adjustment screw on its case while the instrument is in operation.

The meter zeroed in this manner, may show an offset of the needle from zero when the instrument is turned off. This is normal. (The mechanical zero of the meter deviates slightly from the instrument's electrical zero.)

Operating Instructions

DC Mode

1. The line cord should be plugged into 117 volts 60 cycle power.
2. Turn null selector to the V.T.V.M. position and let unit warm up for about ten minutes.
3. After warm up, zero meter by the mechanical zero adjustment.
4. Turn the range selector to the desired range and connect the voltage to be measured to the terminal posts. Either the positive or negative terminal may be grounded to the common terminal or the input may be left floating.
5. When the voltage is applied, the V.T.V.M. will measure it to an accuracy of ±4%. If the needle goes to the left, reverse the input connections.
6. Set the first two readout dials to this approximate reading and advance the null selector to the 1 volt position. Continue to adjust the rest of the readout while increasing the null sensitivity.
7. When the null selector is at full sensitivity (1MV) and the meter is reading zero, read the voltage from the Kelvin Varley dials to an accuracy of better than ±.05% + 5 microvolts absolute. You may not get a reading of zero if the voltage you are measuring is fluctuating.

Operating Instructions - (Cont'd.)

DC Mode

READING EXCURSIONS ABOUT A NOMINAL VOLTAGE

8. To read excursions of voltage about a nominal value, set the readout dials to the nominal value. Excursions may be observed directly on the meter on any of the four null ranges. A right hand deflection of the meter indicates the voltage has increased above the nominal value by the amount indicated on the meter. For voltages read on the 10 volt range and below, use null sensitivity selector as marked. On the 100 volt ranges, the null sensitivity selector value must be multiplied by a factor of 100.

DIRECT MEASUREMENTS OF 10 VOLTS AND ABOVE

9. With the range selector in the 10 volt position, use full scale values as marked on the meter. When range selector is in the 100 volt position, multiply the meter reading by 10. On the 1000 volt range, multiply the reading by 100.

VARIATIONS IN NULL DETECTOR SENSITIVITY

9A. Due to the circuit design on the 100 volt range, the null detector will have reduced sensitivity on the 1 mv and 10 mv position. This is due to a high internal source impedance of the high voltage input divider. The sensitivity is about 50%

Operating Instructions - (Cont'd.)

DC Mode

less in the 1 mv null position and about 15% less on the 10 mv position. Only a very slight loss of sensitivity is noticed on the other null ranges.

When the range selector is in the 1000 volt position a 10% loss of sensitivity will be noticed in the 1 mv position. The other null ranges will have only a very slight loss of sensitivity.

MEASUREMENTS BELOW 1 VOLT IN DIFFERENTIAL MODE

10. When making measurements below 1 volt, turn Range Selector switch to the 1 volt position; set null selector to the 1 mv position; set all readout dials to zero and short positive and negative input terminals together.

11. Now set the mechanical meter adjustment to zero. This will cancel out error due to zero offset between the 1 millivolt range and the V.T.V.M. range. Remove short across terminals and proceed with the reading of voltage per paragraphs 4, 5, 6, and 7.

Operating Instructions (Cont'd.)

AC Mode

12. Follow instructions in the DC Mode, paragraphs 1, 2, & 3.

13. For best results connect the "GND" terminal to the "NEG" terminal although in most applications the input may be left floating.

14. When the Voltage is applied the V.T.V.M. will measure it to an accuracy of ±5%.

15. Set the first two readout dials to this approximate reading and advance the null selector to the 1 volt position. Continue to adjust the rest of the readout while increasing the null sensitivity.

16. When the null selector is at full sensitivity (1 MV) and the meter is reading zero, read the voltage from the Kelvin Varley dials to an accuracy of better than ±0.27. You may not get a reading of zero if the voltage you are measuring is fluctuating.

17. To read excursions of voltage about a nominal value, set the readout dials to the nominal value. Excursions may be observed directly on the meter on any of the four null ranges. A right hand deflection of the meter indicates the voltage has increased above the nominal value by the amount indicated on

Operating Instructions - (Cont'd.)

AC Mode

the meter. For voltages read on the 10 volt range and below, use null sensitivity selector as marked. On the 100 volt ranges, the null sensitivity selector value must be multiplied by a factor of 100.

CIRCUIT DESCRIPTION

DC Section

This Calibration Standards Voltmeter is completely transistorized and designed for long trouble free life. There are no batteries or components that would normally need replacing, except the electro-mechanical chopper.

This dependable voltmeter operates on the principle of comparing an unknown voltage with an adjustable known voltage. A sensitive null detector is used to provide a means of sensing when the known and unknown voltages are equal.

This Calibration Standards voltmeter is composed of three (3) basic elements:

(1) Ultra Stable Reference Supply

(2) Accurate Kelvin Varley Divider

(3) Sensitive Null Detector

1. The heart of the voltmeter is the ultra stable reference voltage supply. This supply is a dual regulated transistor supply powering a compensated Zener reference string. The regulation for a line change from 105 to 125 volts is better than ±.002%. The temperature coefficient of the reference supply is better than .0005%/^{o} C. over a temperature range of 10^{o} C to 40^{o} C. The supply is usable above 40^{o} C with a slight derating of TC and line voltage regulation. Long term stability of

Circuit Description - (Cont'd.)

DC Section

the reference supply is approximately ±.005%/year.

2. The second basic element is the very accurate Kelvin Varley Divider. The first two decks are composed of 11 precision wire wound resistors per deck.

The first deck has resistors matched to -.005% and the second deck has resistors matched to ±.005%. The last three read-outs are accomplished with a selected precision 10 turn potentiometer. The linearity of this potentiometer is better than ±.05%. The two decks and the 10 turn potentiometer are matched together to produce an over-all divider accuracy better than ±.01% absolute.

The range selector precedes the Kelvin Varley Divider. Each range has a fine adjustment potentiometer for calibration; each is calibrated separately. The 10 volt range must be calibrated first.

3. The third element is a very sensitive and stable calibrated null detector. This null detector is used to indicate the difference between the unknown external voltage and known internal voltage. At maximum sensitivity the null detector has a full scale deflection of 1 mv. This provides ample sensitivity for accurate low level voltage measurements. The V.T.V.M. accuracy is

Circuit Description - (Cont'd.)

DC Section

±4% of full scale over a temperature range of 20° C to 30° C. The instrument is usable to 40° C, but some derating should be considered.

It is not recommended that the instrument be operated above 45° C.

The null detector is capable of a long trouble free life except for the occasional replacement of the chopper. These are highly reliable, however, do occasionally need replacement. These are available from stock at the factory. The occasional calibration of the null detector may be made by adjusting the gain adjustment potentiometer at the top of the plug-in amplifier module.

The null detector is capable of large overloads without damage. On the 1 mv range a safe overload would be 50 volts short term and 10 volts long term. On the 10 mv, 100 mv, and 1 V positions, a safe overload of 500 volts is possible.

In the V.T.V.M. position ranges, safe overloads are as follows:

.1	volt range:	20	volts
1	volt range:	70	volts
10	volt range:	250	volts
100	volt range:	700	volts
1000	volt range:	1500	volts

CIRCUIT DESCRIPTION

AC Mode

When measuring AC voltages, an AC-DC Converter is used to convert the AC signal into a proportional DC signal over a range of 0-10 volts. Above 10 volts the AC signal is attenuated to the 0-10 volt level.

The converter, fully transistorized, has the following basic elements:

1. A precision input attenuator. (100:1 and 10:1)
2. A high gain four stage amplifier with an emitter follower output.
3. A half wave silicon diode rectifier and filter network.
4. Full wave current feedback, provided by the silicon diode network.

The closed loop gain of the amplifier is approximately 2. The open loop gain is greater than 100,000 from 30 CPS to 10 KC. The main feedback is full wave and is a function of the current through the silicon diodes. The converter measures the average value and is calibrated in RMS.

CALIBRATION OF AC-100A

DC Section

(Calibrate this section first)

A diagram at the back of this manual shows the location of the calibration potentiometer and a set up used for calibrating this Voltmeter. The Voltage Calibrator, Model C-1, used to calibrate this instrument was designed and built by CALIBRATION STANDARDS CORPORATION. The resistors used in the divider of the calibrator are accurate to .002%. The calibrator has a built in null detector and 100 volt regulated power supply. A Calibrated Standard Cell or Zener Reference was used to provide a voltage standard. If this instrumentation is not used, an instrument of .01% accuracy or better should be used to calibrate the precision voltmeter. Typical of these are Calibration Standards DC-200AR Voltmeter and VC-200AR Precision Voltage Calibrator.

Let instrument warm up for thirty minutes. Calibrate the 10 volt range first. Remove instrument from case. Adjust the 10 volt calibration trim potentiometer when the voltmeter is reading 10 volts with an exact 10 volts applied. (Null Selector positioned at 1 mv). See Drawing #340-062 for location of Calibration Controls. Next, repeat the same procedure on the 1 volt range using the 1 volt calibration potentiometer. Repeat procedure on .1 volt range. On these ranges the meter has an infinite input resistance at null.

Calibration of AC-100A - (Cont'd.)

DC Section

Now set the range switch to 100 volts and 100 volts to the meter (2 Meg. input resistance). Adjust the 100 volt calibration potentiometer. This same procedure may be done on the 1000 volt range by applying 1000 volts and adjusting the 1000 volt calibration potentiometer. Using CSC Model DC-200AR or VC-200AR, the 1000 volt range is calibrated with 100 volts by setting the K. V. D. dial to 100 volts on the 1000 volt range. In order to calibrate the meter this way you must accurately measure the linearity of the divider and make corrections. Even if this correction is not made, a possible error of about .01% may result on the 1000 volt range only.

This completes the calibration of the DC differential section of the voltmeter.

To calibrate the V.T.V.M. ranges, set the range selector to the 10 volt position and apply 10 volts. Adjust the potentiometer at the top of the amplifier plug-in module for full scale deflection.

CALIBRATION OF AC-100A/AR

AC Section

After the DC section of the instrument has been calibrated, the AC section may be calibrated. A very stable AC source must be used along with an AC-DC transfer standard accurate to .05% or better. The Holt Model AVS-321 is recommended for the stable AC source. The setup for this calibration is shown on Drawing Number 340-111.

Calibrate the 10 volt range first. Set AC-100A to the 10 volt range with the readout at 5.0000 volts. Apply an exact 5 volts at 400 CPS. Adjust amplifier gain control located at the top of the converter plug-in module using the 10 mv null range sensitivity. Now change the frequency of the AC source to 10,000 CPS and adjust the trim capacitor located at the top of the converter module. Turn the instrument range selector to the 100 volt range and set the readout at 50.000 volts. Apply 50 volts 400 CPS to the meter and adjust the 100 volt calibration trimpot located on the back of the main calibration board.

Change the frequency to 10,000 CPS and adjust the 100 volt trim capacitor on the calibration board. Change the frequency to 5 KC, and adjust the 100 volt trimpot on the front of the main calibration board. 10 KC and 5 KC may have to be adjusted a few times to insure best calibration. Turn the instrument range selector to the 1000 volt range and set the readout to 500.00 volts. Apply 500 volts 400 CPS to the meter and adjust the 100 volt calibration trimpot located on the main calibration board. Change the frequency to 10,000 CPS and adjust the 1000 volt trim capacitor, also located on the main calibration board. Change the frequency to 5 KC and adjust the 100 volt trimpot on the front of the main calibration board. Readjust 10 KC and 5 KC if necessary. This now completes the calibration of the complete instrument.

WARRANTY

The CALIBRATION STANDARDS CORPORATION warrants each instrument to be free from defects in material and workmanship. Material not covered by this warranty are fuses and choppers. The instrument must be returned to the factory with shipping prepaid and a complete report of the difficulty. This warranty is good for one year from the shipping date.

SHIPPING DAMAGE

If there is any damage to the instrument upon receipt, report this to the transportation Claim Agent immediately.

Calibration Standards Corporation

A subsidiary of ROYAL INDUSTRIES, INC.

Model AC-100A

PRECISION AC-DC VOLTMETER

TRANSISTORIZED

ACCURACY ± .05% + 5 microvolts D.C. ±.2% absolute A.C.

FREQUENCY Converter frequency range is 30 C.P.S. to 10,000 C.P.S.

- Ultra stable Zener package for reference.
- Transistorized throughout
- Light weight—11 lbs.
- No equal in simplicity of operation.
- Recorder Output (25mv).
- 0-10 volts output from Kelvin Varley divider.

GENERAL DESCRIPTION

The Model **AC-100A AC-DC VOLTMETER** is a compact potentiometric voltmeter designed to measure both A.C. and D.C. voltages to a high degree of accuracy. The operation of the instrument is the same for A.C. measurements and D.C. measurements.

The instrument has a 5 digit readout with the last 3 digits readout on a precision 10 turn potentiometer. By using a multiturn potentiometer at the end of the Kelvin-Varley divider, a very high resolution can be obtained.

PRECISION A.C. VOLTMETER

AC-100A

Calibration Standards Corporation

ELECTRONIC INSTRUMENTATION FOR INDUSTRY

A subsidiary of ROYAL INDUSTRIES, INC.

MODEL AC-100A

SPECIFICATIONS

VTVM RANGES	DC 0-1v, 1v, 10v, 100v, 1000 volts. AC 0-10v, 100v, 1000 volts.
NULL RANGES	AC & DC. 0-1mv, 10 mv, 100 mv, 1 volt. (Times 10 on the 100 volt range.) (Times 100 on the 1000 volt range.)
ACCURACY OF PRECISION RANGES	DC ±.05% + 5 microvolts absolute from 0-1000 volts. AC ±.2% absolute from .5v to 1000 volts. 30 CPS tc10,000 CPS.
ACCURACY OF VTVM	DC ±4% Full Scale. AC ±5% Full Scale.
INPUT RESISTANCE	DC Infinite at null below 10 volts, 2 megohms above 10 volts. VTVM Resistance — 1000 volts, 100 volts, 10 volts } 10 megohms 1 volt — 1 megohm .1 volt — 100 K AC 1 megohm on the 10 volt and 100 volt range. 2 megohms on the 1000 volt range. Same on VTVM ranges.
STABILITY OF REFERENCE	±.002% for a ±10% line change. ±.0005%/°C over a temperature range of 10°C to 40°C.
WARMUP	Less than 10 minutes.
INPUT VOLTAGE	105-125 volts AC—50-60 CPS.
INPUT POWER	Less than 6 watts.
WEIGHT and SIZE	11 lbs. 8" w x 7" h x 6" d.
PRICE	$855.00 [redacted] F.O.B. Alhambra, California.

The Model **AC-100A** precision AC-DC Voltmeter is designed to measure both AC and DC voltages to a high degree of accuracy. The instrument measures average volts and is calibrated in R.M.S. Silicon diodes are used in a full wave feedback loop around the converter amplifier. More than 80 db of degenerative feedback is used to provide high accuracy and stability.

Calibration Standards Corporation

1031 WESTMINSTER AVENUE
POST OFFICE BOX 551
ALHAMBRA, CALIFORNIA

A subsidiary of ROYAL > INDUSTRIES, INC.

CALIBRATION DATA

SALE ORDER NO. _____

DATE 11-20-62

MODEL AC-100A

SERIAL NO. 1303

RANGE	D.C. ACCURACY	RANGE	ACCURACY	REFERENCE
1000 V	±.01 %	1000 V.	400 CPS ±.02 10-KC -.04	TEMP COEFF. %
100-V		100-V	400 CPS -.01 10-KC ±.01	VOLTS
10-V		10-V.	400 CPS ±.01 10-KC ±.01	VOLTAGE LINEARITY
1-V			10 KC	FREQ. .06 %
.1-V				

AMPLIFIER

NOISE ¼ DIV.

ZERO OFFSET 1½ DIV.

VTVM 1 %

NULL SENSITIVITY

SCALE OK

1-V OK

.1V OK

10-MV OK

1-MV OK

REMARKS _____

D. A. Smith

TEST TECHNICIAN

DWG. NO 340-054

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CHANGE	DATE	ISSUE	
REVISED AND REDRAWN	7-14-60	C	W.A.T.L.

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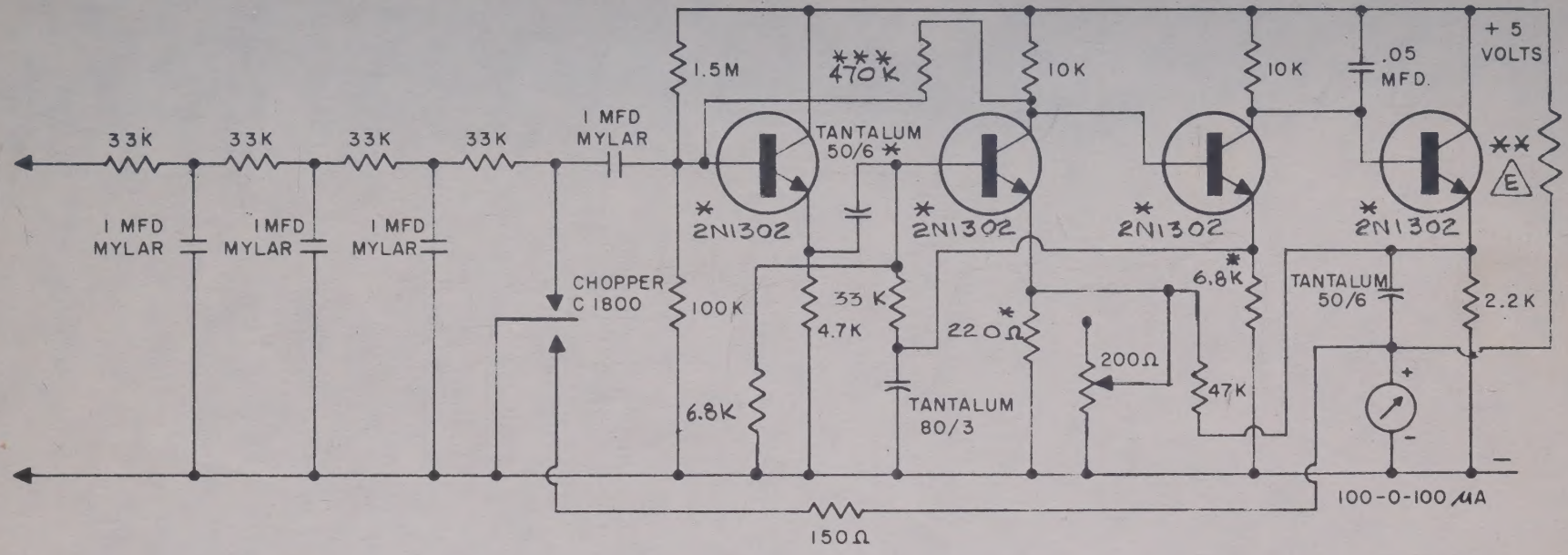

** SELECTED IN-TEST
*** NOT USED IN ALL MODELS

I/N ELECT. CALIB.
D/3272-5

DET.	MATERIAL	QTY.
	* FACTORY SELECTED	
	RESISTORS, 1/2 WATT 10%.	
	METER, SIMPSON MODEL 1329.	
	CHOPPER, JAMES C1800.	

TOLERANCES EXCEPT AS SHOWN
FRACTION ±
DECIMAL ±
ANGLES ±

DATE: 2-2-60
DWN: Wm T Larrabee
CHKD:
APPD:
SCALE

CALIBRATION STANDARDS CORPORATION
POMONA — CALIFORNIA

TITLE: SCHEMATIC, AMPLIFIER

NEXT ASSEMBLY:
USED ON: AC-100A

DRAWING NO. 340-054
ISSUE B

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CS-295-001

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